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**PRELIMINARY RADIATION SURVEILLANCE OF AN AQUATIC SYSTEM
NEAR THE NEVADA TEST SITE
June - July, 1967**

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William L. Klein and Raymond A. Brechbill
Radiological Research Program
Western Environmental Research Laboratory
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ABSTRACT

This report is the culmination of a three-month preliminary radiation surveillance study of an aquatic system in Upper Pahranaqat Lake near the Nevada Test Site. The objectives of this study were to determine the concentrations of fission products in selected samples and to establish the necessary methodology for radiation surveillance in an aquatic ecosystem.

Radionuclide concentrations were found to be insignificant in water, aquatic plant, and fish samples. Sediment samples had detectable levels of ^{137}Cs , ^{40}K , ^{90}Sr , and U. Strontium-90 levels in fishbone were low (2.38 pCi/g bone ash) compared to those found in bovine femur samples (6.9 pCi/g bone ash) collected during the same period.

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I. INTRODUCTION

Biological samples from a freshwater lake near the Nevada Test Site(NTS) were analyzed for the presence of selected radionuclides in order to establish a base line for this particular system and to develop methodology necessary for any further definitive studies of this type.

Although the aquatic system has not been included in the radiation surveillance of the Animal Investigation Program(AIP) studies to date, the possible introduction of radionuclides into man's food chain through fish and waterfowl is acknowledged to be important^{1,2,3}. Tsivoglou, Harward, and Ingram give an informative analysis of this subject⁴. Stream biota constitute at least a partially selective sampling device by concentrating certain radionuclides to high degrees and rejecting others^{5,6}. Aquatic organisms from freshwaters concentrate many elements to many times the level in the water that the organism inhabits. By this process, organisms growing in water containing levels of radioisotopes that would be well below the RPG for drinking water can accumulate certain radionuclides to levels that could limit their use for human food^{7,8,9,10}.

The following are the objectives by which this study was guided:

1. To determine the concentrations of fission products in samples of water sediment and aquatic vegetation obtained from one aquatic system near the NTS.
2. To establish methodology for any future studies of aquatic systems near the NTS.

II. MATERIALS AND METHODS

Since the climate of the region surrounding NTS does not lend itself to the support of an extensive aquatic system, the vast majority of the streams and lakes are seasonal and do not support significant populations of fish and waterfowl. However, there are several important bodies of water in this area from which edible fish and waterfowl are obtained by the general public.

The Upper Pahranaagat Lake on U.S. 93, twenty miles south of Crystal Springs, Nevada, was chosen as the sampling site (Figure 1). This site is approximately fifty miles from the center of the NTS on an azimuth of 60 degrees. The lake is approximately 400 acres in area and is accessible throughout the year. It supports a stable fish population which was present prior to AEC testing on the NTS, as confirmed by Nevada Fish and Game Commission employees. The dominant species of fish in Pahranaagat Lake is carp, *Cyprinus carpio*.

The sources of water for Pahranaagat Lake are Crystal Springs, one mile west of U.S. 93 on Nevada 38, and Ash Springs, six miles south of Crystal Springs.

In several of the past AEC tests which released radionuclides into the atmosphere, the fallout path was in a northeasterly direction, passing over this lake.

Permission for use of Upper Pahranaagat Lake as a sampling site was obtained from the Refuge Manager of the National Pahranaagat Waterfowl Refuge. Sampling locations are shown on the map (Figure 2). The map was prepared by overlaying a quarter-mile by one-eighth mile scaled acetate grid on an aerial photograph. The vertical axes were given numerical designations, and the horizontal axes were given letter designations. The resulting seventeen sampling locations containing portions of the lake were then referred to by their intersects, e.g., E6.

Marking stakes were placed at quarter-mile intervals along the lake. These stakes were used as reference points to locate each of the sampling locations previously designated on the aerial grid. Sampling buoys were prepared from plastic containers. Clay bricks, with mortar locks, were attached to a 50-pound test nylon cord and used as buoy weights.

Table 1 lists the sampling dates and the type and quantity of samples collected.

Table 1. Sample Collections

Collection Dates	Fish	Aquatic Plants	Water	Sediment
June 10, 1967*	4			
June 22, 23, 1967		10	3	
July 11-13, 1967	41			68
July 21, 1967		52	5	

*Collected by Dr. James Deacon, University of Nevada, Las Vegas.

Sampling Methodology.

1. Sediment

Sediment samples were collected with a 9- by 9-inch Ekman dredge. Four samples were taken at each sampling buoy, one within each of the four quadrants formed by the buoy transect lines. Each quadrant sample was collected at no less than 25 and no more than 50 feet from the buoy. Samples were taken in this manner because of the potential sediment variability often encountered in an aquatic system, due to geographical, geological, faunal, and hydrological characteristics.

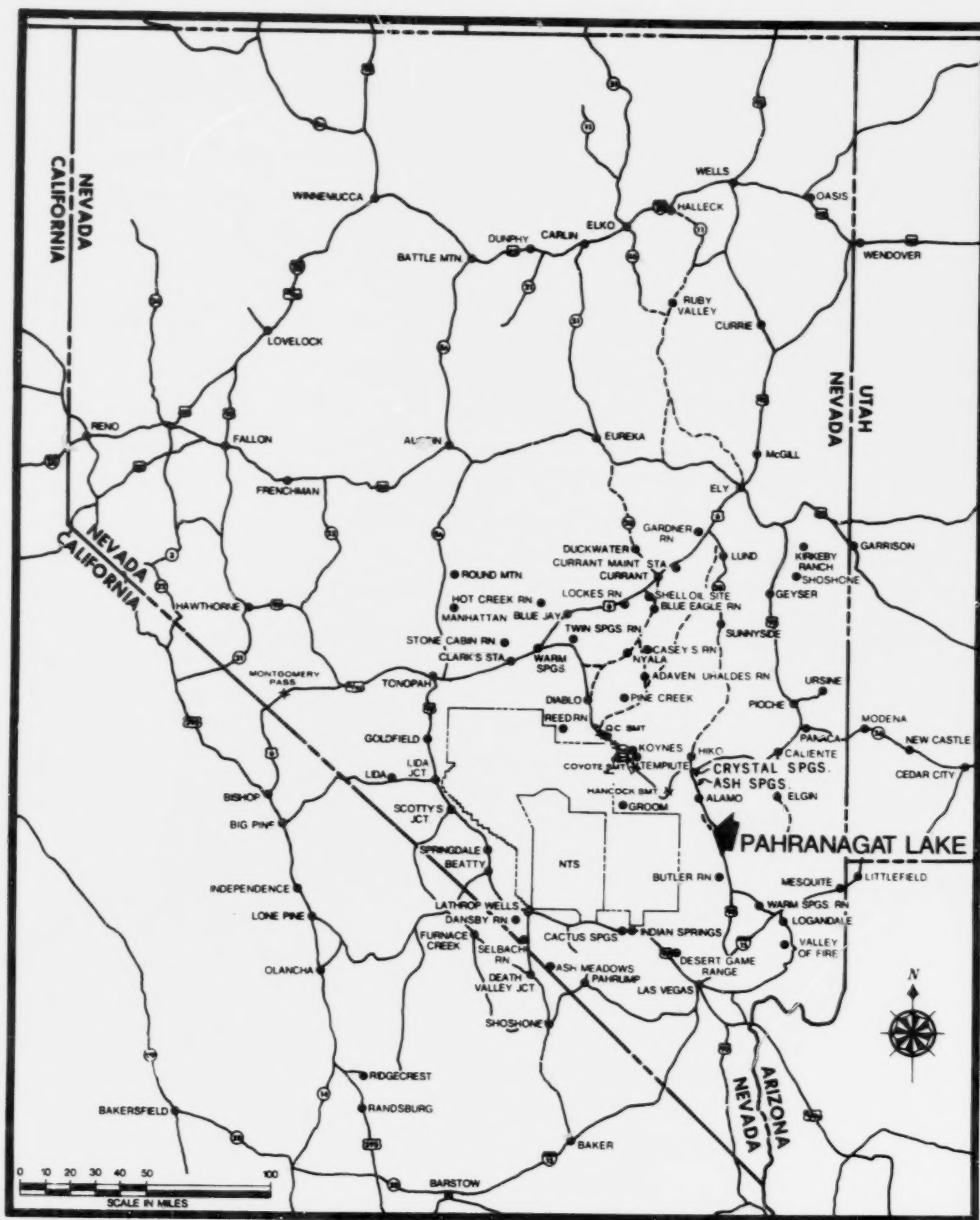


Figure 1. Map of Nevada Test Site and Surrounding Region.

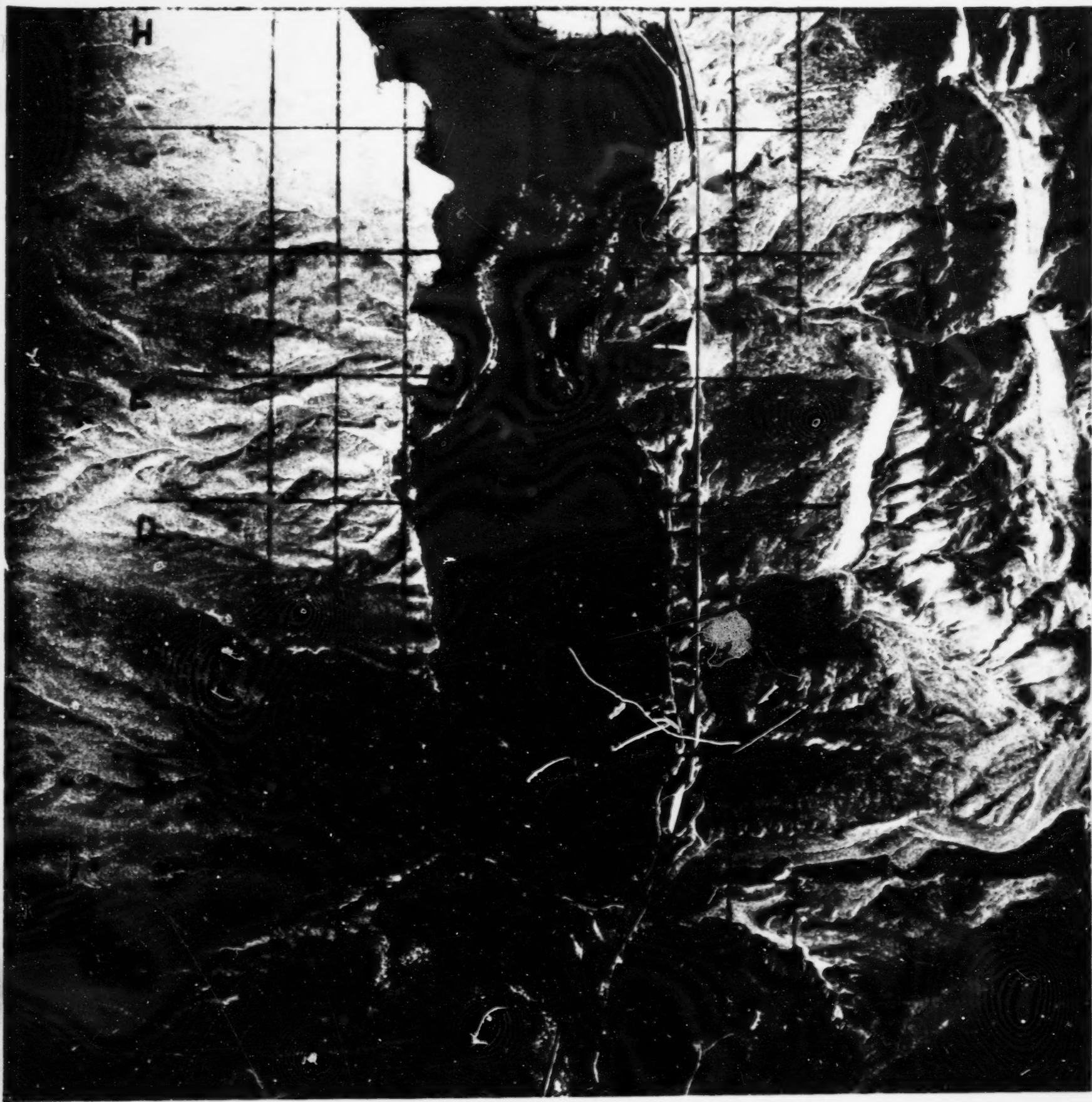


Figure 2. Aerial photo of Pahrnagat Lake with sampling grid.

Sixty-eight sediment samples were collected, four samples at each of the 17 sampling locations. Each sample consisted of 500 ml of sediment, taken from a separate dredging. Samples were placed in 500-ml polyethylene containers and labeled with the location and date of collection. Sample containers were then placed in polyethylene bags which were tied to prevent any sample loss.

Upon arrival at the laboratory in Las Vegas, the samples were recorded in a logbook and sent for gamma spectral analyses.

2. Fish

Four large specimens of carp, *Cyprinus carpio*, were collected from Pahranaagat Lake on June 10. The fish were all approximately 50 cm in length and ranged from 3.5 to 5 kg in weight. On July 12 and 13, 41 additional fish were collected by gill nets. The majority of these fish were over 20 cm in length. All fish collected were carp, *Cyprinus carpio*.

Formalin was added as a preservative. Additional samples of fish scales were collected for age determination by examination of the scale growth rings.

On July 11 and July 21, 1967, the presence of mosquito fish, *Gambusia affinis*, a relative of the guppy, was noted near the shoreline at location D3. Due to the small size of the species, no means of capture was available, and no specimens were taken.

The desirable radioanalysis of fish by age groups could not be accomplished in the time allocated to this study so it was decided to concentrate on the oldest specimens collected.

A total of sixteen of the largest fish was selected. These had a mean age of 3.6 years. Seven different types of composite samples were taken: roe, muscle, eye, gill, scale, viscera, and bone. Samples were placed in 500-ml polyethylene containers. Formalin was added as a preservative. The sample containers were placed in polyethylene bags and kept in a refrigerated truck until arrival at WERL.

The remaining carcasses were placed in polyethylene bags for preparation of bone for strontium-90 analysis.

3. Water

Water samples were collected in the inlet stream and down the length of the lake. A total of eight samples was collected in one-gallon polyethylene containers. Surface samples were taken, because the lake is too shallow and has too much turnover to allow stratification. In a deeper body of water, where stratification might possibly occur, it would be necessary to sample at various levels. The water was not filtered.

A 500-ml aliquot was taken from each sample for gamma spectroscopy.

4. Aquatic Vegetation

Samples of each species of aquatic plants within 50 feet of the sampling buoy were taken at each of the seventeen sampling locations. Aquatic vegetation was collected on June 23 (10 samples), and July 21 (52 samples).

Although there was a fair amount of growth present at the time of the first collection, there was ten times

as much growth on the second sampling run. Seven different species of aquatic vegetation were collected: *Paspalum distichum*, *Potamogeton pectinatus*, *Eleocharis montevidenses*, *Chara asppra*, and *Cladophora* spp., and two species of *Scirpus*. Presentation of the major aquatic plant community in Upper Pahrnagat Lake is given in Appendix II.

Samples were compressed into 500-ml polyethylene containers, labeled and analyzed for gamma-emitting radionuclides.

Table 2. Average concentrations of selected nuclides in wet tissue, pCi/g.

Samples	Total of Composite Samples.	^{40}K	^{106}Ru	^{131}I	^{137}Cs	^{144}Ce	^{134}Cs
Viscera	7	.0026 (7)*	0.18 (1)	.07 (1)	.06 (3)	0.35 (1)	ND $\neq$
Gill	2	.0013 (2)	ND	0.11 (2)	ND	ND	ND
Scale	2	ND	0.18 (1)	0.13 (1)	ND	ND	0.11 (1)
Roe	1	.0041 (1)	ND	ND	ND	ND	ND
Muscle	6	.0028 (6)	ND	.07 (3)	.06 (4)	0.39 (2)	ND
Eye	1	ND	ND	ND	ND	ND	ND

*() = Number of total composite samples in which the radionuclide was detected.

$\neq$ ND = Not detectable.

Table 3. Average concentrations of selected nuclides in sediment and bone, pCi/g.

Samples	Total of Composite Samples	^{40}K	^{106}Ru	^{131}I	^{137}Cs	^{144}Ce	^{134}Cs	^{90}Sr
Sediment	68	.0021 (59)*	0.29 (32)	0.30 (61)	0.30 (67)	2.08 (64)	0.23 (67)	0.33 $\neq$
Bone	1							2.38**

*() = Number of total composite samples in which the radionuclide was detected.

$\neq$ = pCi/g wet sediment

** = pCi/g bone ash

III. RESULTS AND DISCUSSION

The average concentration of nuclides in the samples is presented in Tables 2 and 3. Detectable levels of ^{137}Cs , ^{40}K , and U were found in the sediment samples. This is to be expected since both ^{40}K and U are naturally occurring, U being commonly found in sediments throughout the Southwest. Cesium-137 is an aged fission product, a part of worldwide fallout, which would be expected to be found in samples of this type. The traces of ^{131}I found in most samples could have come from the Umber test which released radioactivity to the atmosphere at the Nevada Test Site June 29, 1967. Strontium-90 levels in the fishbone composite were low (2.38 pCi/g ash) as compared to those of the bovine femur samples collected routinely by the AIP (Table 3). The mean value of ^{90}Sr for five bovine femur samples collected in the spring of 1968 was 6.9 pCi/g bone ash.

No significant levels of fission products were found in the plant, water, or fish samples. Difficulties in determining the validity of the data were encountered with all samples due to the low levels of activity present. The sample counting time of 20 minutes, which was used, proved to be too brief.

In regard to sediment sampling, the Ekman dredge was not found to be practical at all sampling locations. At some stations, the bottom vegetation was so profuse as to prevent the dredge from biting into the sediment. At stations near the perimeter of the lake, the bottom sediment was very hard, due to annual drying as the lake decreased in area through the summer months. These factors alone, or in combination, limited the use of the dredge. The dredge functioned best at the stations located centrally down the length of the lake. At these points, the increased depth and current flow contribute to a decrease in bottom vegetation and sediment compactness. Depending on

the time of the year, the dredge should be operable at most of the sampling locations at Pahrnagat Lake. After the cold weather has decreased the amount of bottom growth and the cessation of irrigation has permitted the replenishment of the lake's water supply, the dredge should operate at maximum efficiency.

Fortunately, one of the factors which caused the abundance of bottom growth, shallow depth, also permitted sampling by direct collection. The maximum depth of the lake at the time of collection was approximately 10 feet. Once through the bottom growth, the sediment in the more central locations was easily collected by merely diving down to the bottom with a container in hand and manually scooping up the desired samples. Collection of samples at the peripheral locations was more tedious. The extreme hardness of the bottom sediment at these points necessitated actual digging for sample material.

A methodological problem involved in direct collection of this type is that of obtaining stratified samples. The advantage of an Ekman dredge is its ability to take a uniform sample several inches in depth. At the locations where use of the dredge was not feasible, care was taken to collect the upper several inches of sediment, rather than "surface skimming."

All of the problems which were encountered during this preliminary study would serve as useful guides in the organization and execution of a long-range definitive study of systems in the NTS region if such were to be undertaken. In addition, the insignificant levels of fission products reported are of some value as background data.

IV. SUMMARY

Analysis of samples taken during this study indicated no significant levels of fission products in biological samples collected in Upper Pahranaqat Lake. Methodology was developed which enables the WERL Animal Investigation Program to be in a state of readiness should there be a need for surveillance of aquatic ecosystems in the NTS region.

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APPENDIX II
The Major Aquatic Plant Community of
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DIAGRAM SHOWING THE LOCATIONS OF PREDOMINANT GROWTH OF *Chara aspera* , *Cladophora* spp.

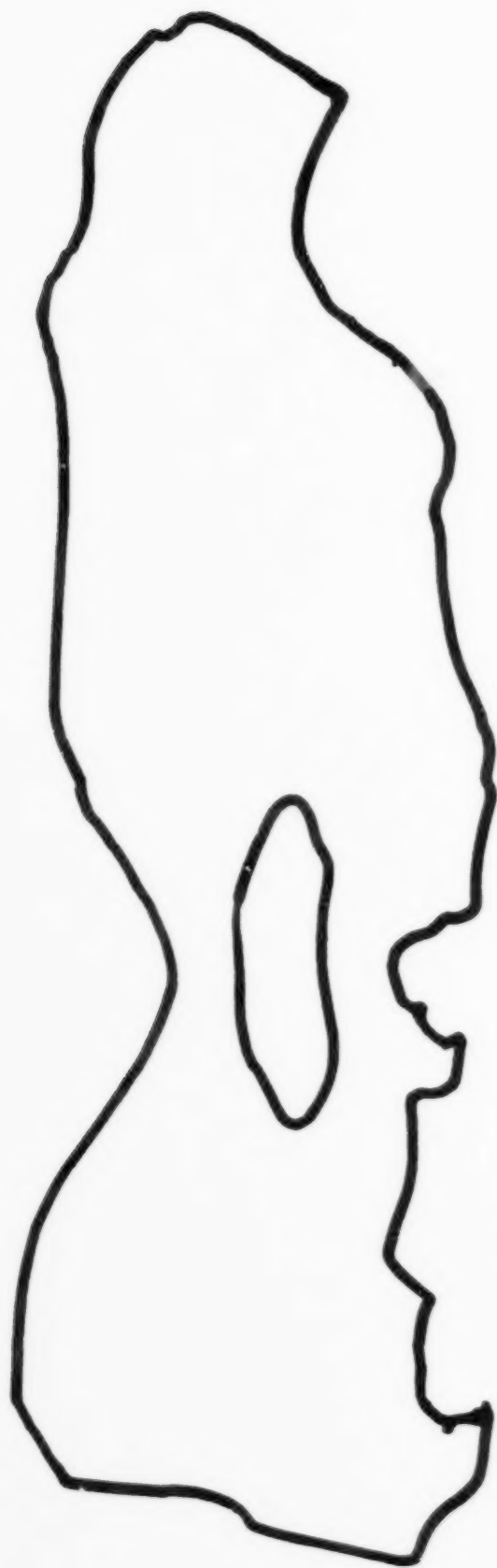


DIAGRAM SHOWING THE LOCATIONS OF PREDOMINANT GROWTH OF *Potamogeton pectinatus*



DIAGRAM SHOWING THE LOCATIONS OF PREDOMINANT GROWTH OF 2 SPECIES OF *Scirpus*

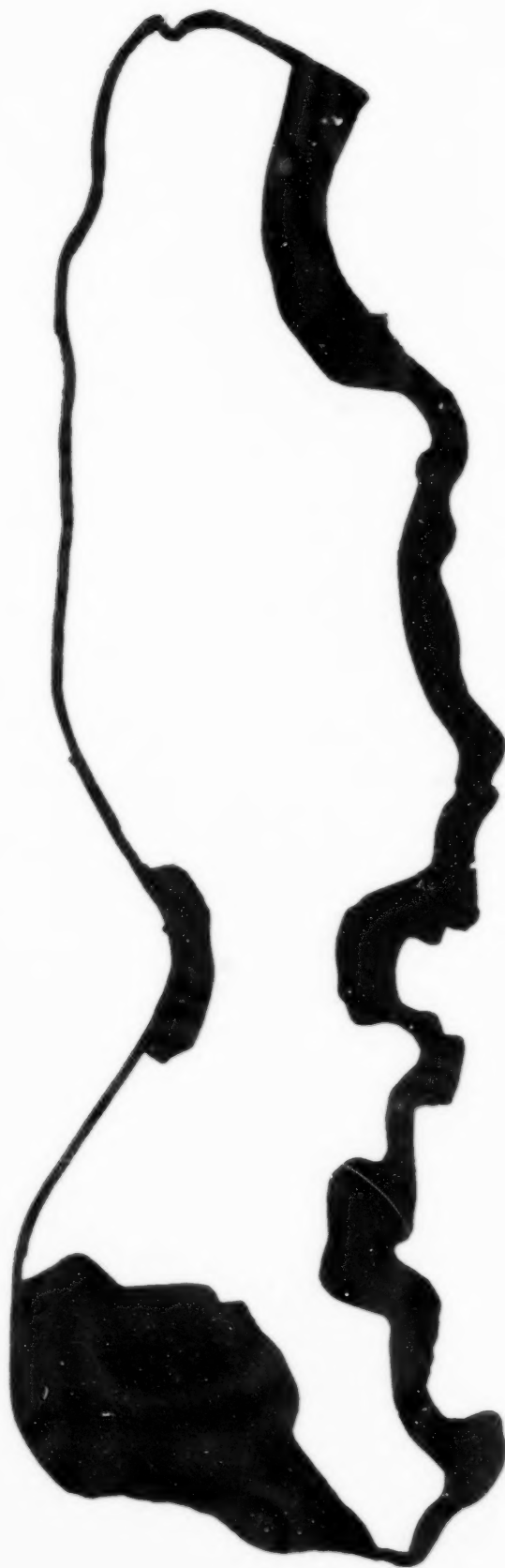


DIAGRAM SHOWING THE LOCATIONS OF PREDOMINANT GROWTH OF *Eleocharis montevidense*



DIAGRAM SHOWING THE LOCATIONS OF PREDOMINANT GROWTH OF *Paspalum distichum*